



TENNESSEE BUREAU OF INVESTIGATION

Forensic Services Division

Microanalysis Standard Operating Procedures Manual

Direction of Force and Order of Breakage Determination

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1. Scope

The purpose of this procedure is to analyze a pane of glass to determine the direction a force an object was moving when glass was broken and in the case of multiple impacts, determine the order in which the forces occurred.

2. Terms and Definitions

Concentric - having a common center, as circles or spheres.

Radial - made in the direction of a radius; going from the center outward or from the circumference inward along a radius.

Conchoidal fractures – shell-like fracture patterns formed in broken glass by the application of force.

3. References

Miller, E.T. "Forensic Glass Comparisons", Forensic Science Handbook, Prentice-Hall, Inc., NJ, 1982, 139-153.

Fisher, Barry A.J. Techniques of Crime Scene Investigation, Elsevier Science Publishing Co., Inc., New York, 1987, 164-172.

Saferstein, Richard. Criminalistics, Prentice-Hall, Inc. New Jersey, 1998, 115-120.

Thornton, J.I. and Paul J. Clashman. "Glass Fracture Mechanism -A Rethinking", Journal of Forensic Science, JFSCA, Vol. 31, No. 3, July 1986, 818-824.

4. Examination Procedures

4.1. Evidence Types

The submitted evidence can include but is not limited to: broken panes of window glass, broken laminated automobile windshields, occasionally tempered side and back automobile windows, and plastic window products (Pexi-glass, Lexan, etc.).

4.2. Instruments and Equipment

Photographic equipment with accessories



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Ultraviolet Lamp

4.3. Procedural and Chemical Precautions

Refer to the TBI Safety Manual for general safety requirements and hazard information regarding the use of reagents and solvents, and overall safety guidelines.

Use caution and appropriate hand protection when handling sharp glass fragments.

4.4. Limitations

Medium or low velocity impacts may produce contradictory crater patterns.

No opinion can be made as to the size or shape of the projectile causing the break.

Heat stresses and mechanical stresses after the impact may create additional cracks that will not behave as described and confuse interpretation.

4.5. Procedure

Document submitted samples according to *Microanalysis Quality Assurance Policy*.

Accurately document with photographs, notes, and/or sketch the broken glass as it was received.

If the pane needs to be reassembled:

Determine if the glass is of float manufacture using an ultraviolet (UV) lamp set to short wavelength. Float glass will fluoresce on one side. Using this, all of the pieces can be properly oriented for assembly.

Mark each piece as to where it was found and (optional) which face is inside or outside, if known. As many pieces as possible should be reassembled.

Once the pane is reassembled the impact points should be identified and documented.



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When a force impacts a pane of glass, radial cracks form at the center of the impact and run radially outward or in a somewhat star-shaped pattern from the point of impact.

Concentric fractures form concentric circular cracks in the glass around the point of impact.

To determine the direction of force, identify a radial crack that terminates at the point of impact.

The edge of the glass along the radial crack may be examined to observe the conchoidal fractures (also known as hackle marks or radial ridges).

These ridges appear to be perpendicular to one face of the glass and parallel to the other face of the glass.

The direction of force can be determined by using the “4R” rule:

Ridge lines on Radial fractures are at Right angles to the Rear (side opposite the impact).

Direction of force of high-velocity impacts can be determined by observing the crater pattern that occurs on the opposite side of the glass from the impact.

On laminated glass, other indicators may be examined to aid determination of direction of force, i.e. bulging on one side or laminate extruding out one side, or crater formation.

When two more projectiles penetrate a pane, the sequence may be determined because the cracks caused by the second and subsequent impacts will terminate at any previously formed cracks.

5. Measurement Traceability

There are no measurements involved in this examination.

6. Reference Materials

No reference materials are used.

7. Reports

Results should provide an indication of the direction the force that an object was traveling at the time of the impact.



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If multiple impacts were involved, then a discussion of the order in which the impacts occurred would be expected.

If an opinion could not be made due to the condition of the sample or some other problem, an inconclusive result is reported listing the reasons for this interpretation.

The exact wording of the results will vary from case to case due to the uniqueness of each sample.